Title: Tick Treatments: Getting the Most Out of Private Control Programs While Protecting Water Quality

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Abstract: Significance of the work: Ticks, especially lone star ticks, are a rapidly expanding problem in the Northeast. This project focused in part on lone star ticks as well as deer ticks, using field research rather than laboratory research. This grant helped us to develop standardized research on the field efficacy of "organic" tick control products, some of which have little information on their labels. By gathering data from workshop participants, we are both educating about ticks and their ecology for better control but we also were able to gather information from local practitioners regarding what cultural controls or products they are using, What was learned or accomplished: Three workshops were given, servicing over 140 members of the industry and other entities and were so popular that we ran out of room and already have over thirty participants scheduled for another workshop to be run on April 6, 2017. We have had a request to replicate the workshops in Westchester County. There was overwhelming interest in the use of GoogleEarth Pro as a planning tool for treatment. We determined the most common products being used in our cross section of participants and are in the process of testing these on a local basis to provide replicated research for creating and enhancing best management practices for tick control particularly with respect to "green products". Research is still on-going but so far results have indicated the following: Greatest mortality was obtained using Mavrik Perimeter with 97.5% mortality 10 DAT compared to 31.5% reference mortality for lone star tick adults and 100% mortality 16 DAT compared to 35% reference mortality for lone star nymphs. The next best performance was the Cedar Safe product (with 85% cedar oil AI) which produced 47% mortality at 10 DAT compared to reference mortality of 31.5% for lone star tick adults but only 37% mortality at 16 DAT compared to 35% reference mortality for lone star nymphs. These results again point to the utility of hybrid control programs using both "green" products and synthetic products, green closer to points of human contact and synthetic as a perimeter treatment.

Background and Justification:

Northeast tick research has largely focused on the deer ticks (*Ixodes scaularis*), not lone star (*Amblyomma americanum*) ticks. Lone star ticks continue to spread at a very rapid rate according to research, perhaps partly a result of climate change (Ludwig et al. 2016). Lone star ticks are closely linked with deer populations which are also expanding rapidly (USDA APHIS Report, 2014). Published literature includes lab and field based studies for existing synthetic pesticides but many newer products such as natural oils or organic products have little available

lab data and even less available field trial data. In addition, existing field trials have widely variable methods making efficacy comparisons between studies or products unreliable. Further field trials are need as products often perform differently in controlled laboratory conditions versus field and the ability to directly compare product efficacy for different species of ticks is paramount. Products tested locality specific to the tick and its life stages will better ascertain potential efficacy levels for widely used materials and application techniques under real world conditions specific to the Northeast. Otherwise, the unknown field efficacies for products already existing on the market will remain elusive. Active ingredients were chosen based on several factors including continued pest control operator feedback for currently used products for tick control. Additional ingredients were chosen for field evaluation upon review of existing literature, tick control articles purporting the use of new, natural products with little to no available field data, or ingredients with limited existing field data for one or both tick species of interest. Because of the prevalence of routine tick control treatments, we need data to help evaluate the potential impact of these treatments on water quality and the fragile environment of Long Island and to help us fine tune best management practices to reduce overall applications, to target applications to the individual tick species present in that location and to create resources and educational programs that will help applicators to think before they spray such as using programs like GoogleEarth Pro. Using such a program not only allows applicators to plan for sensitive plantings or with concern for pollinators, but also to enhance environmental stewardship by streamlining treatment protocols based on each area's unique characteristics, land use intention, client concern, topography (chance of runoff so avoid granular products, etc.), and tick species.

Objectives: 1. Develop a free educational program for professionals treating consumer properties for ticks. The program will be repeated three separate times, and each will include five hours of education. Topics will include the DEC discussing proper licensing and details of treating ticks on individual properties, integrated tick management (ITM), a discussion of exempt products for tick treatment including pros, cons and which products have not been sufficiently tested, and a review of equipment and techniques for tick treatment including some hands-on activities. As a part of this program, a survey on what products the participants are using as well as what techniques are used and where their clients are relative to various at risk water bodies around Long Island will be administered. There will be a section where they can indicate willingness to participate in a cooperative effort with Suffolk County Vector Control so that vector control has a better idea of common practices for tick control.

2. Create close collaborative relationships with private industry both to educate and to obtain information on the products and techniques used for tick control. Our second objective would be to determine what to test of the most common exempt products (those that are used more heavily and haven't been tested for efficacy) and develop better protocols for the private industry in terms of their applications and efficacy monitoring.

3. A third objective is laboratory and field research using the five most popular exempt products for tick reduction in the landscape as per survey of green industry contractors practicing tick control on Long Island. Results from this research will be presented at conferences and meetings in an effort to raise awareness and to improve and standardize integrated tick

management while helping to protect water quality on Long Island through best management practices.

Procedures: Workshops-Three free, 5 hour workshops were given to landscape professionals with content as listed in attached agendas and handouts. We serviced a total of 43, 47 and 51 professionals in the workshops. The programs proved so popular that we ran out of space and already have more than thirty professionals interested in a similar program on April 6, 2017. EVALUATION: a survey on what products the participants were using as well as what techniques were used and what they would change as a result of our seminars was administered. The following information was obtained:

Products most commonly in use as per participant survey:

Trade name	Active Ingredient (AI)	Percent AI, respectively
Eco-via EC	Thyme Oil, 2-Phenethyl Propionate, Rosemary Oil	20%, 14 %, 8%
	Bifenthrin	?
4-poster (2)	permethrin	10%
	Rosemary and wintergreen oil	?
	Cedar oil and rosemary oil	?
Buzzkill cedar oil (2)	Cedar oil	
Up-Star	Bifenthrin	0.2%
Ecozap activator	Rosemary and peppermint oil, thyme oil, clove oil, geraniol, cinnamon oil, sesame oil "octopamine"	Rosemary Oil..... .....5.0% Peppermint Oil.....2.0% Thyme Oil.....2.0% Clove Oil.....2.0% Geraniol.....5.0% Cinnamon Oil.....0.5% Sesame Oil.. .....0.5%
Permethrin SF-R	Permethrin	?
Tick killz (4)	Cedar oil, 2-phenethyl propionate, peppermint oil	39.7%, 14.7%, 1%
	citronella	?
Skeeter defeater	Pyrethrins, PBO	0.5%, 4%
Organocide	Sesame and fish oils	5%, 92%
Cedar safe (2)	Cedar oil	85%
Induce spreader sticker	?	?
Baseline	Bifenthrin	23.4%
Tick free (2)	Cedar oil and 2-phenethyl propionate	27.5% and 4.7%
Astro (3)	Permethrin	36.8% (mixed cis-trans)

Tempo (SC ultra?)	Beta cyfluthrin	11.8%
	Neem oil	?
Talstar	Bifenthrin	7.9%
Essentria 3 (2)	Peppermint and rosemary oils and geraniol	2%, 10%, 5%
	Peppermint oil	?
Mosquito free	Cedar oil and 2-phenethyl propionate	65.8% and 14.2%
	Rosemary oil	?
	Rosemary and wintergreen oils	?

The five most common were cedar oil alone, cedar oil in combination with other ingredients, bifenthrin, permethrin, and combinations of rosemary and peppermint oils with geraniol. The primary method of application was by back pack sprayer and it was discovered through interactive discussion during panels that formulations containing rosemary oil was very destructive to O rings in sprayers. A vendor was able to suggest a type of O ring (Viton) that would not be degraded easily as a replacement and so we had an impact of suggesting a remediation to increase efficacy and reduce off target applications. Additionally, we were informed that participants should be careful because some people will claim a seal is Viton but you will be able to tell because it is a dark brown color vs. a clear color. Other points of discussion included phytotoxicity following application of rosemary oil products and whether cedar mulches as barriers were effective and how they could best be used.

How does what they are applying stack up against information available? It is often difficult to find exact products with replicated research results in the literature. Many times, there are different percentages of active ingredients or difficult to compare data. When literature was reviewed, we found the following information on the most common products in use by our survey recipients:

Cedar oil: Eller et al., 2014, working with cedrol and deer tick nymphs, found they exhibited dosage-dependent mortality and when exposed to 6.3 mg/ml experienced 100% mortality.

Cedar chips: Research by Piesman in a laboratory setting found chips from Alaska yellow cedar *Chamaecyparis nootkatensis* impede nymph movement but lost this ability within a week of outdoor exposure. However, Alaska yellow cedar sawdust remained effective up to four weeks after outdoor exposure. Also, different cedars have different compounds in them, so it is unknown what is actually in an individual batch of cedar mulch. As of 2016, "field studies are still lacking to quantify the protective efficacy of barrier treatments, including different barrier materials, placement and widths" (Larsen and Dolan, 2016).

Nootkatone (a component of cedar oil): Jordan et al., 2011, using 2% Nootkatone (not commercially available) achieved 96.5 and 91.9% control of *I. scapularis* and *A. americanum* through 42 days and 35 days, respectively. Nootkatone spray using low pressure in one week produced an 82% reduction, nanoemulsion, 84%, dual spray nootkatone 100% in one week, lignin encapsulated in one week produced 100% residential kill of ticks. Some of the nootkatone type products will continue to kill for up to 6 weeks but the stuff is

tremendously expensive and not available yet. They are trying to develop a way to encapsulate, but there was greater than 90% loss from lignin encapsulation one week after application in field. Now they are trying polyencapsualtion.

Geraniol: Component of citronella. A field trial on the efficacy of 1 % geraniol spray against Hyalomma ticks has been carried out in two farms near Rabat (Morocco). Comparison of geraniol sprayed cows with control herd showed a reduction of mean number of ticks per animal of 98.4 %, 97.3 % and 91.3 % at respectively day 7, 14 and 21 post-spraying. The evaluation of 10 essential oils of geranium, *Pelargonium graveolens* (Geraniaceae), were all shown to have repellent activity against nymphs of the medically important lone star tick, Amblyomma americanum (L.). Biological tests were carried out using a vertical filter paper bioassay, where ticks must cross an area of the paper treated with repellent to approach host stimuli. One of the essential oil samples that repelled >90% of the ticks at 0.103 mg/cm2 was selected for further fractionation studies. Effective compounds, such as (−)-10-epi-γ-eudesmol, found in geranium oil, have the potential for commercial development.

Rosemary oil: Two percent carvacrol (a component of thyme oil) and EcoTrol T&O (rosemary oil) required two applications because control declined significantly to 76.7 and 73.7%, for deer and lone star ticks respectively, after 14 d. The second application extended control to between 86.2 and 94.8% at 21 d for each tick species respectively but there was phytotoxicity to herbaceous plants from rosemary oil.

Peppermint oil: Could not find replicated research on this compound alone

Phenethyl propionate: Derivative of peanut oil: EcoSmart for pets or a spray for landscape, Tick Killz spray for landscape. Tick Free organic tick control: Cedar Oil 27.5% 2 Phenethyl Propionate 4.7%, EcoVia: Thyme Oil - 20.0%, 2-Phenethyl Propionate - 14.0% , Rosemary Oil - 8.0% .

Pyrethrins: Natural insecticidal compound derived from Chrysanthemum. Field trials: greater than 90% reduction of deer tick nymphs one week after application, but at 2 weeks 60-66% then at 3-6 weeks less than 25%. Pyrethrin breaks down in response to light and oxygen. Burridge et al., 2003, found that lone star nymphs were significantly more sensitive to cyfluthrin, permethrin, and pyrethrins than against other acaricides tested. Pyrethrin, one week after treatment with a low pressure spray produced a 95% deer tick nymph reduction. Pyrethrin soap one week after treatment with a low pressure spray produced a 93% reduction in deer tick nymphs. Pyrethrin soap plus alcohol one week after treatment with a low pressure spray one produced 100% reduction. Desiccant dust plus pyrethrin produced 100% reduction one week after treatment.

Carvacrol: Two percent carvacrol (a component of thyme oil and of essential oil in heartwood of Alaska yellow cedar) and EcoTrol T&O (rosemary oil) required two applications because control declined significantly to 76.7 and 73.7%, for deer and lone star ticks respectively, after 14 d. A second application extended control to between 86.2 and 94.8% at 21 d for each tick species, respectively, but there was phytotoxicity to herbaceous plants from rosemary oil. Carvacrol produced one week after low pressure dual application scheme produced 88% reductions, and with a single scheme 83% reductions. (Definition of a "dual" application = 2 well timed back pack sprayer applications two weeks apart). One study with carvacrol showed control greater than 75% reduction for up to 4 weeks.

Eco-Exempt IC2: rosemary oil plus peppermint oil. Elias et al., 2013, looked at the rosemary oil product Eco-Exempt IC2 for all stages of the deer tick using summer nymph and fall adult peaks using high pressure spray and a comparative treatment of Bifenthrin and found both

products to be equally effective, reducing all stages by 100% with a single application. Eco-Exempt IC2 has been taken off the market due to phytotoxic damage to plantings.

Rosemary peppermint and wintergreen oils: Low pressure sprays after one week produced reductions of 37% and high pressure sprays after one week, produced reductions of 100% (Elias, 2013).

General patterns: General pattern for natural products as acaricides if treated with single low pressure spray applications: control of deer tick nymphs for 1-3 weeks. Control beyond the 3 week window can be achieved by a single HIGH pressure spray application OR multiple low-pressure spray applications. Natural based products appear to be more sensitive to environmental conditions vs. traditional counterparts.

Changes participants felt they would make as a result of our seminars included the following (many participants had similar survey answers):

-More application techniques would be tried

-Different, more targeted treatment intervals would be adopted based on enhanced knowledge of individual tick lifecycles and the results of flagging/dragging individual properties

-flagging and dragging would be adopted, or modified as a result of demonstration

-use of bifenthrin would be adopted

-improved calibration techniques would be adopted, or modified as a result of demonstration

-those working with mosquitoes as well as ticks would adopt larval sampling and there were several requests for a similar workshop that was devoted entirely to mosquitoes with more demonstrations

-they would consider drawbacks to organic products including efficacy and lack of sufficient labeling and incorporate those caveats into their treatment routines

-different product selection

-consider the implication of spreader stickers on efficacy and whether leaf surface or under leaf surface/leaf litter applications were needed depending on target tick type

-consider off target effects of tick treatments

-Take into consideration equipment (application type) effect on control, detrimental effects of formulation on seals, etc.

-Check for updated local research information prior to treatments

-Take into better consideration the best synthetic acaricide for tick management particularly with respect to proximity of water

-and, overwhelmingly popular, they would incorporate the use of GoogleEarth Pro protocols and property planning (there were multiple suggestions for a longer, interactive breakout training for this)

Additionally, the DEC instruction was highly valuable and very interactive with the audience, addressing points of confusion on what constituted a legal application of tick products to lawn and landscape versus a dwelling perimeter treatment and the type of license required. These presentations dovetailed with recommendations to consider a hybrid program with a "green" alternative for tick treatments around dwellings and a synthetic perimeter treatment coupled with the cultural control of a wood chip barrier along the perimeter. Participants were also reminded that if you are supervising an applicator, you must have the same category license as the people you are supervising.

Participants also learned through interactive sessions that certain equipment may perform better with respect to the type of tick and their lifecycle and behaviors. As an example, Stihl equipment is better at stirring up the leaf litter which may mean better contact of product with deer ticks and dog ticks since they are highly driven by humidity and often spend long periods of time hiding close to the ground and in the leaf litter.

Who attended the workshops: We had a good representation from all across the island including companies and entities from the following zip code areas (more than one company can be represented by an individual zip code):

11021 Allenwood
11053 Port Washington
11542 Glen Cove
11560 Locust Valley
11568 Old Westbury
11702 Babylon
11706 Bayshore
11710 Bellmore
11716 Bohemia
11717 Brentwood
11721 Centerport
11731 Elwood
11738 Farmingville
11743 Huntington
11747 Huntington Station
11741 Holbrook
11749 Ronkonkoma
11751 Bayberry Point
11769 Oakdale
11771 Center Island
11727 Coram
11776 Port Jefferson Station

11777 Port Jefferson Station
11779 Ronkonkoma
11782 Sayville
11784 Selden
11791 Laurel Hollow
11901 Riverhead
11934 Center Moriches
11935 Cutchogue
11937 East Hampton
11947 Jamesport
11949 Manorville
11952 Mattituck
11957 Orient Pt.
11958 Peconic
11964 Shelter Island
11967 Shirley
11968 South Hampton
11969 South Hampton
11971 Southold
11980 Yaphank
11973 Upton
11942 East Quogue

Results of research for 2016 (the research will continue on into 2017 as will additional workshops beyond the three required for the grant) were as follows (please see attached excel file entitled All Field Trials 2016 w result tables FINAL):

The products tested locally in 2016 included Essentria IC3 (Peppermint and rosemary oils and geraniol at 2, 10 and 5 percent), EcoVia (Thyme Oil, 2-Phenethyl Propionate, and Rosemary Oil at 20, 8 and 14 percent), Cedar Safe (85% cedar oil active ingredient, and has 15% ethyl lactate), Tick Kilz (39.7% cedar oil plus 14.7% 2-phenethyl propionate and 1% peppermint oil), Mavrik Perimeter (tau-fluvalinate 22.3%) and water alone as a reference control. Mavrik Perimeter was tested as a promising alternative to bifenthrin. Greatest mortality was obtained using Mavrik Perimeter with 97.5% mortality 10 DAT compared to 31.5% reference mortality for lone star tick adults and 100% mortality 16 DAT compared to 35% reference mortality for lone star nymphs. The next best performance was the Cedar Safe product (with 85% cedar oil AI) which produced 47% mortality at 10 DAT compared to reference mortality of 31.5% for lone star tick adults but only 37% mortality at 16 DAT compared to 35% reference mortality for lone star nymphs. These results again point to the utility of hybrid control programs using both "green" products and synthetic products, green closer to points of human contact and synthetic as a perimeter treatment. For the other products, reference mortality was actually greater than mortality in treated plots, possibly due to protective effects (due to possible reduction of questing behavior via repellent nature of some ingredients) of products or from drought stress mortality in test subjects. At 10 DAT, Essentria IC3 induced 30.5% mortality versus 31.5% reference mortality,

Tick Killz induced 27% mortality versus 32.5% reference mortality and EcoVia induced 19% mortality compared to 32.5% reference mortality.

Petri dish trials: Issentria products used on adults produced 100% mortality at 13 days compared to 30% mortality in reference plots where 1000 square feet including the petri dish containing ticks were treated. High mortality within 48 hours of nymphs in reference plates means these trials will have to be repeated to get meaningful data.

Results and Discussion: **What is the impact of this project?** We obtained and continue to obtain valuable information concerning the use and efficacy of "green" alternatives to synthetic pesticides including efficacy, timing of applications as a function of tick type and tick life stage. We have learned the identity of some of the most common products in use on a regular basis and have begun testing them under controlled conditions. We have found so far that the most effective "green" product being used locally is one with the highest amounts of cedar oil as an active ingredient. We have tested a highly effective alternative to Bifenthrin. The impact of bifenthrin on pollinating bees is defined as " Group 1—HIGHLY TOXIC. Severe bee losses may be expected if the following pesticides are used when bees are present, if the product is applied near beehives, or if bees forage in the application area within a day after treatment." https://www.clemson.edu/public/regulatory/pesticide_regulation/bulletins/bulletin_5_protecting_honeybees.pdf .

In contrast, the active ingredient of Mavrik Perimeter, tau-fluvalinate, is actually used as a miticide for varroa mites. According to http://www.beeccdcap.uga.edu/ documents/caparticle2.html,

"… its success as a varroacide is somewhat surprising since the class of pesticides to which it belongs, the pyrethroids, contains many pesticides that are exceedingly toxic to bees. One of them, cyfluthrin (Baythroid) has an LD_{50} - the dose at which 50% of the bees in a group will die - of just 62 nanograms (the smaller the LD_{50} the more toxic). Yet tau-fluvalinate, just a few chemical tweaks different from cyfluthrin, has a generous LD_{50} of 9450 nanograms making it 150 times safer to bees. The utility of tau-fluvalinate as a miticide depends on the robust tolerance bees have for this pesticide. As it turns out, bees tolerate the large quantities of tau-fluvalinate present in Apistan because they are very good at detoxifiying it …"

By encouraging participants in the workshop to change the synthetic pyrethroid used in their programs from bifenthrin to tau-fluvalinate we are encouraging them to secondarily protect pollinator populations. Additionally, repetitive blanket spraying of green alternatives such as botanical oils can have devastating effects on natural predator and parasitoid populations yet have comparatively little effect on target ticks so we encouraged workshop participants to think about this and to communicate the information to their customers. According to Ndakidemi et al., 2016, address the direct and indirect effects of products perceived as "safe" because they are botanical, such as essential plant oils:

"The use of synthetic and botanical pesticides has detrimental effects to both natural enemies and pollinators….Non-lethal effects of botanical pesticides may inhibit the ability of natural enemies to establish populations, suppress the capacity of natural enemies to utilize prey, reduce prey availability, affect parasitism or consumption rates; decrease reproduction, inhibit

ability of natural enemies to recognize prey; influence the sex ratio (females:males), and reduce mobility, which could impact prey-finding [47]. Beneficial arthropods' activities will consequently be promoted if more knowledge will be provided in understanding the non lethal effects and the botanical pesticides that cause these effects."

This grant established valuable contact between the industry and the tick research component of Suffolk County Vector Control with many participants stating during the panel portions that they would be keeping active contact in order to update vector control on what they were seeing in the field and to obtain updated results of vector/extension research projects as they acquire useful data on the products the industry indicated they were using. Data from the projects will be presented at the Suffolk County Ag Forum and NSLGA conference in January and again at the Cauliflower Association and PCA of Long Island Conferences, Suffolk County Golf Course update in February, and the Extension Horticulture conference in March. It will also be presented in depth at the tick grant workshop repeat in April and will be presented in condensed form to the public during presentations to the Long Island Horticultural Society, the Spring Gardening School in April and at the Hauppauge Public Library in May. Additional factsheets will be developed for updates on best management practices for tick control once all of the research data is in. In this factsheet will be incorporated some of the research that has previously been done (as well as local research) including highlights from the following:

-A review by Eisen and Dolan, 2016, emphasizes that a multifaceted tick control approach is more successful than a simple concentration on acaricides and also reviews the importance of the type of spray and schedule.

-Studies funded by Center Internal Grants (USDA/NIFA/Regional IPM Centers such as http://projects.ipm.gov/ProjectDetails.cfm?project_ID=801 Trial of a Novel, Pasture-Safe, Botanical Compound to Control Lyme Disease Vector Ticks, 2008, http://projects.ipm.gov ProjectDetails.cfm?project_ID=1323 Barberry removal to decrease Lyme disease risk: a demonstration project, 2013, http://projects.ipm.gov/ProjectDetails.cfm?project_ID=462, IPM to Control Vector Ticks on Public Lands, 2007, http://projects.ipm.gov/ProjectDetails.cfm?project ID=767, Trial of a Minimum-risk Botanical Compound to Control the Vector Tick of Lyme Disease, 2009, and http://projects.ipm.gov/ProjectDetails.cfm?project_ID=1140, Managing for biodiversity and reduced tick-borne disease risk in a metropolitan landscape, 2011.

-Additional publications by Bharadwaj et al., 2015, which looked at the effects of garlic juice on deer tick nymphs over three seasons at a rate of 0.2g A.I./sq. m and found that at 6, 11, and 18 days post application there was 37%, 59%, and 47.4% control on average. Elias et al., 2013, looked at the rosemary oil product Eco-Exempt IC2 for all stages of the deer tick using summer nymph and fall adult peaks using high pressure spray and a comparative treatment of Bifenthrin and found both products to be equally effective, reducing all stages to O with a single application. Jordan et al., 2011, using 2% Nootkatone (not commercially available) achieved 96.5 and 91.9% control of *I. scapularis* and *A. americanum* through 42 days and 35 days, respectively. Two percent carvacrol (a component of thyme oil) and EcoTrol T&O (rosemary oil) required two applications because control declined significantly to 76.7 and 73.7%, for deer and lone star ticks respectively, after 14 d. The second application extended control to between 86.2 and 94.8% at 21 d for each tick species respectively but there was phytotoxicity to herbaceous plants from rosemary oil. Eller et al., 2014, working with cedrol and deer tick

nymphs, found they exhibited dosage-dependent mortality and when exposed to 6.3 mg/ml experienced 100% mortality. Allan and Patrician, 1994, achieved poor results (16% mortality) with diatomaceous earth treatment of deer tick nymphs. Burridge et al., 2003, found that lone star nymphs were significantly more sensitive to cyfluthrin, permethrin, and pyrethrins than against other acaricides tested.

By digesting this research and summarizing it on a fact sheet for the layman and the pest control operator, we will provide a resource so that they will be able to understand and utilize what has already been proven or disproven by replicated research rather than placing faith in marketing or testimonials.

New, continued or modified research planned for 2017: Although the grant is being reported on now, at the end of 2016, the research continues through 2017 with products purchased as a result of the grant and to capture windows of tick type and life stage activity that preceded the grant funds and work begun in late June 2016. We will furnish a full report on this as it unfolds to provide a complete set of data and analyses.

Products for field efficacy testing in 2017

Products for priority testing on **deer ticks** in 2017

Product Name	**Active Ingredient 1**	**2nd A.I.**	**3rd A.I.**
Mavrik Perimeter	Tau-fluvalinate	-	-
Essentria IC3	Rosemary	Peppermint	Geraniol
Essentria All Purpose	Rosemary	Pepermint	-
EcoVia EC	Thyme Oil	2-Phenethyl Propionate	Rosemary
Tick Killz	Cedar oil	2-Phenethyl Propionate	Peppermint oil
Cedar Safe	Cedar oil	-	-

Would allow comparison of efficacy between deer tick and lone star ticks for each product

Secondary products for testing on **lone star** or **deer ticks** in 2017

Pyrethrin based products with and without plant wash and diatomaceous earth added to tank mix

Product Name	Active Ingredient 1	2nd A.I.	3rd A.I. 3rd
Pyronyl Oil Concentrate OR-3610A	Pyrethrins	PBO	
Evergreen Pyrethrum Concentrate	Pyrethrins OMRI Listed	-	-
Evergreen Crop Protection EC 60-6	Pyrethrins	PBO	
Pyganic Crop Protection EC 5.0	Pyrethrins OMRI Listed	-	
Pyronyl 303 EC	Pyrethrins	-	-
Plant Wash	Potassium Salts of Fatty Acids		
Diatomaceous earth	-	-	-

With determined efficacy data for the pyrethrin based products we could then examine synergistic efficacy effects. Tank mixes using plant soap or diatomaceous earth with these products could be tested as non-published results noted an increase level of control for mixtures of these products with hydraulic applications on deer ticks.

Tertiary products for field efficacy testing in 2017 would include synthetic pyrethroid products widely used for tick control.

Product Name	Active Ingredient 1	2nd A.I.	3rd A.I. 3rd
Tempo SC Ultra	ß- Cyfluthrin	-	-
Talstar Xtra Verge	Bifenthrin	-	-
Upstar Gold Granular	Bifenthrin	-	-
Deltaguard G	Deltamethrin	-	-
Suspend SC	Deltamethrin	-	-
Suspend polyzone	Deltamethrin	-	-
Astro	Permethrin	-	-
Lamda 9.7 CS	Lamda-cyhalothrin	-	-

New or modified topics planned for 2017 workshops:

-Green/Natural based product integrated tick management programs for residential properties

-Review of current efficacy data for products tested by SCVC and CCE on both deer tick and lone star ticks

-Using an aerial GPS program such as GoogleEarth Pro, design an integrated tick management program **live** during the course reviewing the numerous obstacles, land use intentions and

various concerns potential client have. The management program could be altered numerous times quickly to allow integration of attendee questions or concerns into the process. Reviewed briefly and reinforced via a handout, the GPS based maps could be used to increase their applicators efficiency on the property and provide a professional detailed program map to their clients allowing easy visualization of the program in total. Area would be defined using the GPS programs built in polygon feature. Defined area could include treatment type, high use areas, no treat areas, sensitive plantings or concern for pollinators, pools, swing sets, gardens and numerous other areas which may require defining. Polygon measurement feature would be reviewed to show its use in providing measurements for acaricide use calculation and subsequent pricing for applications and other management strategy. With the property areas defined, treatment protocols would be compiled based on each areas unique characteristic, planting type, land use intention, client concern, topography (chance of runoff so avoid granular products, etc.), and tick species. An integration of various tick management strategies and acaricide use would be combined in each area, where applicable, to maximize tick management while minimizing acaricide use, and improving environmental stewardship.

-Review of the non-acaricide tick management strategies that could be used on properties **to: 1** appease clients who wish to minimize acaricide usage and improve or allow tick management services on properties that have sensitive areas such as apiaries **and: 2** allow service providers additional services to complete during period when acaricides can't readily be applied, such as rain days e.g., vegetation management, leaf litter removal, adjusting irrigation systems, host exclusion fencing and tick sampling.

-Discussion of hybrid program utilizing green/natural products on the more sensitive areas of the property while utilizing the longer efficacy of synthetic products on the property edges or hot spots. Another option would be using synthetic products in integrated programs to initially reduce the tick population and then switching to the green/natural products to maintain the population at acceptable levels.

Project location(s): Demonstration/education projects: Suffolk County, Nassau County and Westchester County Workshop Participants, Workshops were conducted in central and eastern Suffolk. **Research projects:** Applicable across the northeast.

Samples of resources developed:
See attached files

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